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a report on research and technical developments in the Soviet heavy electrical equipment industry. The report includes information on AC transmission, DC transmission, rotating electrical machinery - hydroelectric generators and turbogenerators, and transformers.

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Technical Notes on Russian
Heavy Electrical Engineering

1. AC TRANSMISSION

(a) Stability

In the case of EHV lines stability is at present assessed on the usual assumption of line/line/ground fault but the future intention is to assess stability only on a single line/ground fault. Considerable improvements have been made in static stability to dv/dt and d^2v/dt^2.

(b) Design

The most modern Russian equipment has rectifier control excitation and this is popular with designers of synchronous apparatus. This technique enables machines with normal characters to be used on 500 KV systems.

(c) Series Capacitors

Banks at sub-stations are designed for installed loads of 420 KV. In 1957 on the line KUYBYSHEV to MOSCOW the load was stepped up as a trial to 500 KV and this load is still being carried with no reported breakdown.

(d) Basic Insulation Levels

420 KV capacitors (see Para. 1(c) above) are all tested for initial levels of 1,800 KV.

(e) Circuit Breakers

Circuit breakers are not tested at twice their basic insulation levels. Circuit breakers made at ELEKTROAPPARAT are rated at 20,000 MVA, 500 KV and 15,000 MVA, 220 KV. For test purposes ELEKTROAPPARAT have 2 x ½ million volt transformers set up in cascade and impulse generaters of two million volts. Four or five 4.5 million volt impulse generators are inthe course of production at ELEKTROAPPARAT.

/(f) Mechanical Troubles

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500 KV lines using triangular bundles of conductors have had trouble with spacing but this is said to have been cured. The trouble arose from "galloping conductor" effects experienced at 0°C. conditions. The present arrangement is to couple conductors in pairs with two to three feet spacing.

(g) STALINGRAD Hydro Power Station

Groups of 3 x 105 MW generators are connected to a bank of transformers. Two such groups are then connected to a single 500 KV circuit for a sub-station. The above gives in effect a 630 MW generation. A third 500 KV circuit is connected through an autotransformer to 2 x 105 MW generators and a 220 KV system. By this means the station has voltage 1,470 MW for export at 500 KV.

(h) Computors

The technical use of computors for system analysis and transformer design is not so far advanced as it is in the West. However, at the Transformer Factory at ZAPOROZHYE a new computor has just been installed purely for use on design work.

2. DC TRANSMISSION

(a) In Russia it is considered that the economics of DC transmission are not justified below 750 MW and for distances of over 1,000 kilometres. There is no unanimity of opinion for the adoption of DC in the U.S.S.R.

(b) Considerable secrecy is maintained regarding research and development in the field of high voltage DC transmission. Visitors are not permitted to examine modern valves which are now said to be made in an entirely new factory. A valve in the MOSCOW Exhibition has a design based on obsolescent German (A.E.G.) practice.

(c) The STALINGRAD -Don Bas DC scheme scheduled for completion in 1960 is not likely to be completed until 1961. 50X1-HUM

/(d) HV DC Circuit Breakers

(d) HV DC Circuit Breakers

None of these is to be seen by visitors. All problems connected with such breakers have been solved in principle but detailed development work is still necessary. It is considered that, when in being, a device including an oscillating circuit at 700 KV would cost the same as equivalent equipment for a 3-phase AC circuit breaker at the same voltage. A large team of research workers has been engaged on problems of HV DC circuit breaking for several years.

3. ROTATING ELECTRICAL MACHINERY

(a) Exhibition of Economic Achievements USSR

Particulars are on show of a projected 590 MVA (500 MW) 125 r.p.m. vertical hydro generator for KRASNOGORSK on the Yenisey River. This machine will be designed to use water-cooled stator windings and forced air-cooled field windings. Reference at the Exhibition is also made to new 300 MW turbo generators under construction and to a projected 600 MW single unit machine for steam. 100 MW gas turbine-driven generators are also shown as being planned.

(b) Hydro Generators

At the STALINGRAD Power Station sixteen out of twenty-two 105 MW 68.2 r.p.m. generators are installed and running. These are of the "umbrella" type. Two further similar units are being installed and four more are still under construction at ELEKTROSILA, LENINGRAD. Earlier machines of the same type at KUYBYSHEV are fitted with DC exciters and pilot exciters but machines for STALINGRAD have large diameter AC exciters. The thrust bearings of these machines are of the KINGSBURY/MICHELL double row type and carry a load of 3,600 tons. Figures for specific loadings show them to be 58/65 kg. cm^2. The above particulars apply to units still under construction at ELEKTROSILA. This plant also has a U.S.S.R. state order for forty-two sets of 120 MW hydro generators having water-cooled

stators.

(c) Turbo Generators

(i) The largest unit nearing completion at ELEKTROSILA is a 165 MW set. This set has water cooling but only of one conductor in three. Also at ELEKTROSILA there is a 300 MW turbo generator in the preliminary stage of construction; completion of this set is scheduled for the end of 1960.

(ii) ELEKTROSILA have designed a 750 MW 2-pole turbo generator using water as a coolant for the stator and rotar and hydrogen for core cooling.

(iii) The latest figures for turbo generators at ELEKTROSILA show an annual output of 3 million KW. This production comes from a turbo shop with a floor area of approximately 100,000 sq. ft. and 66 ft. head room.

4. TRANSFORMERS

(a) MOSCOW Transformer Factory

(i) This factory specialises on the smaller types of transformers such as are associated with furnaces, railway equipment and test apparatus. The factory can, however, produce power transformers up to approximately 120 MVA while utilizing their standard frames.
The factory buildings themselves are old and dirty and housekeeping is very bad. Head room is very restricted and the largest crane has a maximum lift of only 75 tons. The plant is not laid out for building large units.

(ii) The plant employs 4,200 people with an annual output of of 12 million KVA.

(b) ZAPOROZHYE Factory

(i) This factory is far more modern than the one at MOSCOW. It is better laid out and housekeeping is far superior with a floor area

with a floor area less congested. The factory is capable of producing all sizes of standard transformers; the largest transformer so far produced is one having a rating of 240 MVA. 360 MVA, 20/242 KV, 3-phase transformers have been designed but none has yet been built. As designed, these transformers will weigh 335 tons including oil.

(ii) Engineering Laboratory

The laboratory has a 5 million volt 230 kilojoule impulse generator and a 1.5 million volt one amp power frequency test set consisting of 3 x 500 KV units in cascade. There is also a large DC generator for testing HV DC transmission transformers and large vacuum drying and oil impregnating equipment. There is one 500 KV prototype transformer of about 100 MVA rating in the course of assembly.

(iii) The ZAPOROZHYE factory employs 6,000 people and has an annual output of 20 million KVA.

(c) Steel

Russian transformer steel is cold reduced grain oriented steel (C.R.O.S.). Figures show that the quality of Russian steel used by the MOSCOW Transformer Factory (see Para. 4(a) above) is rated at .7 watt/lb; the comparable figure at ZAPOROZHYE is .51 watt/lb. The steel used at ZAPOROZHYE is of the same quality as that produced by the STEEL COMPANY of WALES. Some of the transformer steel used in the U.S.S.R. is without phosphate magnite coating.

(d) Cores

Russian core design, without being obsolete, is not advanced. Assembly cores are often very wavy, particularly in the case of machines having small ratings.

(e) Windings

Russian high voltage windings are of the section type with only

/rudimentary static shields

rudimentary static shields at the line ends. Sections taped for reinforcement are usually very spongey compared with Western practice. Multiple sheets of kraft paper are often used for insulation. Aluminium windings are frequently employed, especially in the case of the smaller sizes of transformers. This applies particularly to the ZAPOROZHYE Transformer Factory.

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